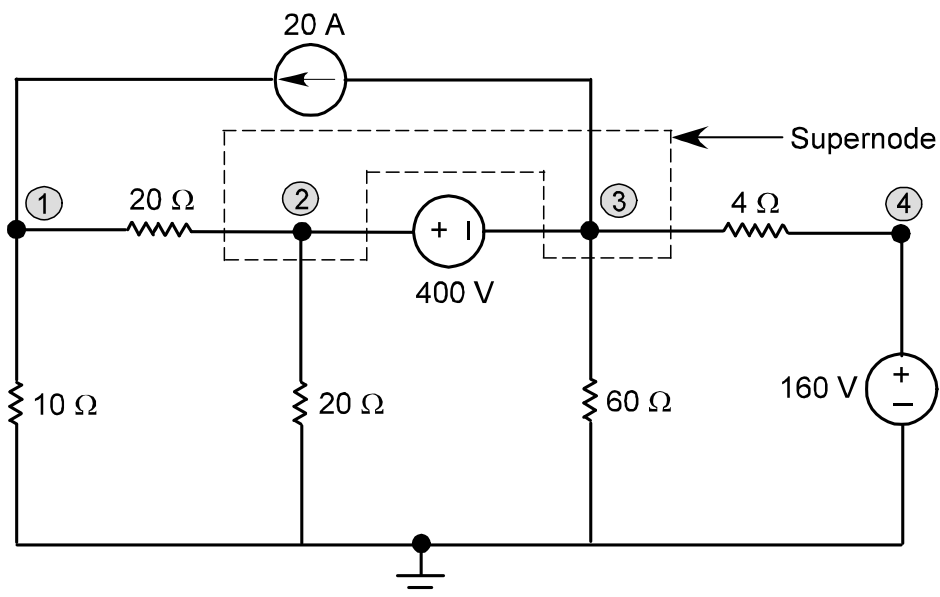


Homework Set #12
DUE Tuesday, April 4, 2017

1.
a) Write the nodal equations needed to solve for all nodal voltages in the following circuit. **Do not attempt to solve these equations.**



$$V_2 = V_3 + 400 \text{ and } V_4 = 160$$

$$\frac{V_1}{10} + \frac{V_1 - V_2}{20} - 20 = 0$$

$$\frac{V_2 - V_1}{20} + \frac{V_2}{20} + 20 + \frac{V_3}{60} + \frac{V_3 - V_4}{4} = 0$$

- b) Assume the answer to part (a) is the following set of equations (NOTE: this is **not** the answer to part (a)). Solve them for all nodal voltages.

$$V_2 = V_3 + 600 \text{ and } V_4 = 240$$

$$\frac{V_1}{10} + \frac{V_1 - V_2}{20} - 15 = 0$$

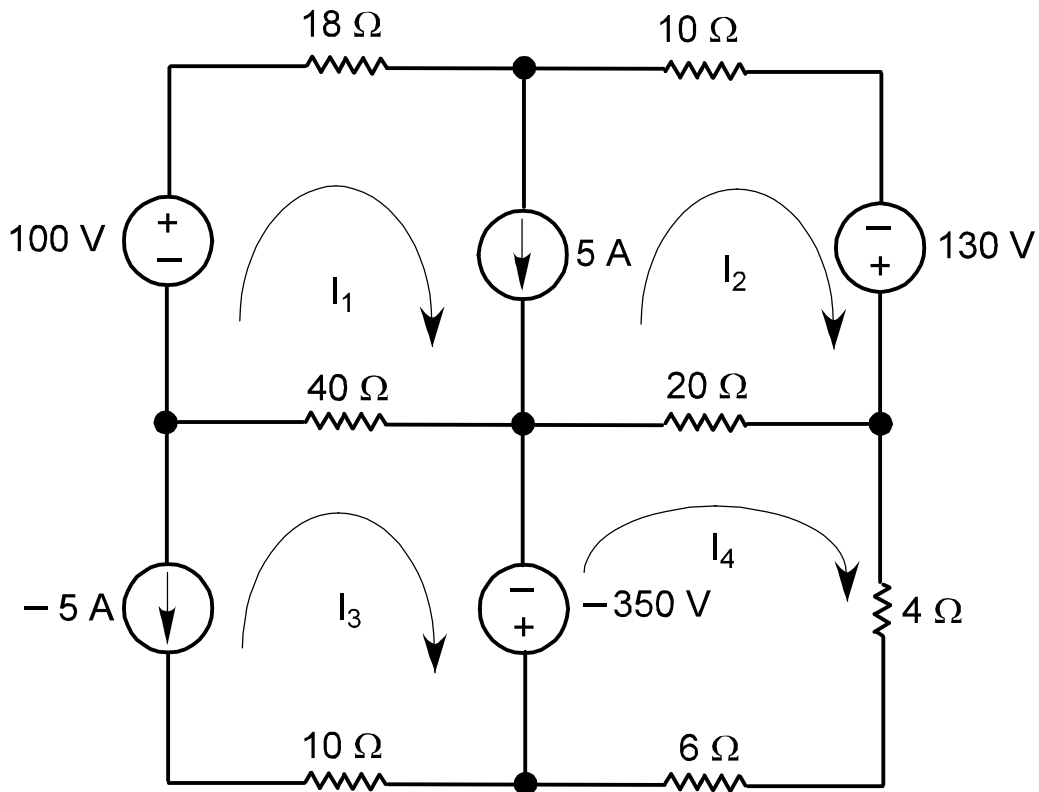
$$\frac{V_2 - V_1}{20} + \frac{V_2}{20} + 15 + \frac{V_3}{60} + \frac{V_3 - V_4}{4} = 0$$

The above equations give: $0.15V_1 - 0.05V_2 = 15$ and $-0.05V_1 + 0.3667V_2 = 205$

Which solve to: $V_1 = 300 \text{ V}$, $V_2 = 600 \text{ V}$ and $V_3 = 0 \text{ V}$

2.

- a) Write the mesh equations needed to solve for all mesh currents in the following circuit. **Do not attempt to solve these equations.**



$$I_1 - I_2 = 5$$

$$I_3 = 5$$

$$-100 + 18I_1 + 10I_2 - 130 + 20(I_2 - I_4) + 40(I_1 - 5) = 0$$

$$-350 + 20(I_4 - I_2) + 10I_4 = 0$$

Which solve to: $I_1 = 10 \text{ A}$, $I_2 = 5 \text{ A}$ and $I_4 = 15 \text{ A}$ (**Not Req^d.**)

- b) Assume part of the answer to part (a) is $I_4 = 10 \text{ A}$ (NOTE: this is **not** the answer to part (a)). Determine the power **produced** by the -350 V source.

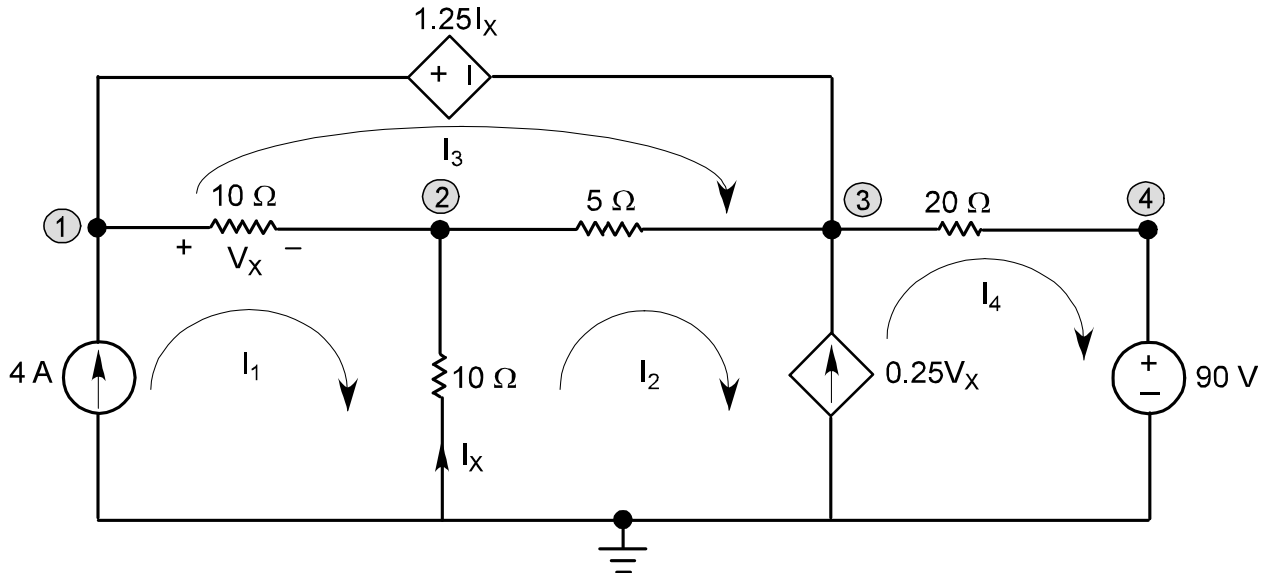
Given: $I_{-350\text{V}} = I_4 - I_3 = 10 - 5 = 5 \text{ A}$

Because $I_{-350\text{V}}$ enters the "+" terminal the power "consumed" is given by:

$$P_{-350\text{V}} = +(-350) \times I_{-350\text{V}}$$

$$P_{350\text{V}} = (-350) \times 5 = -1750 \text{ W (consumed)} = +1750 \text{ W (produced)}$$

3. For the following circuit:
 a) determine all nodal voltages using nodal analysis, and
 b) determine all mesh currents using mesh analysis.



a) Nodal analysis:

$$V_1 = V_3 + 1.25I_x \text{ and } I_x = -0.1V_2 \text{ so } V_1 = V_3 - 0.125V_2 \text{ also } V_4 = 90 \text{ V}$$

$$-4 + \frac{V_1 - V_2}{10} - 0.25V_x + \frac{V_3 - 90}{20} + \frac{V_3 - V_2}{5} = 0$$

Since: $V_x = V_1 - V_2$ then

$$-4 + 0.1(V_1 - V_2) - 0.25(V_1 - V_2) + \frac{V_3 - 90}{20} + \frac{V_3 - V_2}{5} = 0$$

$$-0.15V_1 - 0.05V_2 + 0.25V_3 = 8.5 \text{ and } V_3 = V_1 + 0.125V_2$$

$$\text{so } 0.1V_1 - 0.01875V_2 = 8.5$$

$$\frac{V_2 - V_1}{10} + \frac{V_2}{10} + \frac{V_2 - V_3}{5} = 0$$

$$-0.1V_1 + 0.4V_2 - 0.2V_3 = 0 \text{ so } -0.3V_1 + 0.375V_2 = 0$$

Which solves to: $V_1 = 100 \text{ V}$, $V_2 = 80 \text{ V}$ and $V_3 = 110 \text{ V}$

b) Mesh analysis:

$$I_1 = 4 \text{ A} \quad I_4 - I_2 = 0.25V_x \text{ and } V_x = 10(4 - I_3) \text{ also } I_x = I_2 - 4$$

$$I_4 - I_2 = 10 - 2.5I_3 \text{ which leads to: } -I_2 + 2.5I_3 + I_4 = 10$$

M3: $1.25(I_2 - 4) + 5(I_3 - I_2) + 10(I_3 - 4) = 0$ gives: $-3.75I_2 + 15I_3 = 45$

SM2/4: $10(I_2 - 4) + 5(I_2 - I_3) + 20I_4 + 90 = 0$ gives: $15I_2 - 5I_3 + 20I_4 = -50$

Which solves to: $I_1 = 4 \text{ A}$, $I_2 = -4 \text{ A}$, $I_3 = 2 \text{ A}$ and $I_4 = 1 \text{ A}$